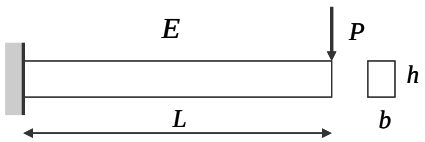
4th Assignment – Monte Carlo method

Consider the timber cantilever beam shown in the figure below.



Using the Bernoulli equation, the displacement at the free end is given by

$$u = \frac{PL^3}{3EI}$$

where E is the Young's modulus of the material, P is the applied loading, L is the length of the beam, $b \times h$ are the dimensions of the cross-section and $I = bh^3/12$ is the moment of inertia. The length of the beam is L = 4 m, the dimensions of the cross-section are b = 15 cm, h = 25 cm and the applied load P = 2000 N. The properties of the timber material are determined through a series of tests with results as given in Table 1.

Table 1. Tensile strength and Young's modulus from tests on timber specimens (provided by Lehrstuhl für Holzbau und Baukonstruktion, TUM).

Specimen #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Tensile strength [N/mm²]	37.1	36.9	40.5	46.8	37.6	30.0	29.0	27.5	30.7	43.9	29.2	28.7	18.3	34.3	35.0	58.0	20.9
Young's modulus [N/mm²]	10237	6951	12242	20814	18815	13005	9886	8155	11437	11718	8348	9368	10123	11677	10770	9993	8808
Specimen #	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Tensile strength [N/mm²]	26.8	18.4	34.0	28.4	35.2	27.1	38.0	28.0	30.3	54.9	55.4	32.8	39.5	19.3	54.2	23.1	50.3
Young's modulus [N/mm²]	11598	9530	10669	12648	11765	12076	12950	8799	7841	12568	11830	11676	9576	8364	12574	6611	12399
Specimen #	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
Tensile strength [N/mm²]	66.5	32.7	35.7	36.2	26.4	54.8	27.5	25.3	48.3	47.7	52.9	29.9	42.4	24.8	28.9	26.0	
Young's modulus [N/mm²]	14024	12176	10796	11384	10330	12723	12608	7956	12886	10771	11158	9223	10457	8278	8587	9928	

Create a Matlab program (*.m file) that computes the statistics of the displacement of the beam applying Monte Carlo simulation. Also, the program should compute the probability of failure, where failure is defined as the event of the displacement exceeding the threshold of 40 mm. The program should perform the following tasks:

- Import the data stored in the given Timber.dat file and extract the values of the Young's modulus.
- Use the Matlab built-in function *lognfit* to fit the data of the Young's modulus to the lognormal distribution.
- Compute the statistics of the displacement by Monte Carlo simulation, using 1000 samples. Generate plots of the displacement samples, such as the histogram, the cumulative frequency diagram and probability plots for different distribution types. What is the distribution of the displacement?
- Compute the probability of failure. Make sure that the coefficient of variation of the estimate is smaller than 10%.